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# THESIS

RELATIONSHIP BETWEEN THE ARMED SERVICES  
VOCATIONAL APTITUDE BATTERY (ASVAB) AND  
PERFORMANCE IN FLEET READINESS SQUADRON (FRS)  
ACOUSTIC OPERATOR TRAINING

by

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March 1986

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Relationship Between the Armed Services Vocational  
Aptitude Battery (ASVAB) and Performance in Fleet  
Readiness Squadron (FRS) Acoustic Operator Training

by

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Submitted in partial fulfillment of the  
requirements for the degree of

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## ABSTRACT

The purpose of this thesis is to determine whether the Armed Services Vocational Aptitude Battery (ASVAB) scores, specifically the composite of ASVAB subtests (AR + 2MK + GS) used to predict eligibility for formal training in the Aviation Antisubmarine Warfare Operator (AW) rating, can actually predict the success or failure of enlisted personnel attempting the P-3 fleet readiness squadron (FRS) Acoustic Operator syllabus. This was accomplished by computing a Pearson Product - Moment Correlation Coefficient, corrected for restriction in range, to determine the correlation between ASVAB subtest and composite scores and success or failure in the FRS syllabus. The results indicate that ASVAB scores are only slightly predictive of performance.

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## I. INTRODUCTION

### A. OVERVIEW

The Armed Services Vocational Aptitude Battery (ASVAB) is the primary instrument used by the Navy in the selection and initial assignment of enlisted personnel to Navy ratings (jobs) and their associated technical schools. Initial technical training (usually class "A" schools) performance often determines follow-on technical training and resulting ultimate duty station and billet assignments that are the key to an enlisted person's career.

Because the ASVAB scores are key factors in rating selections for enlistees, it is important to determine if the scores are predictive of performance in the ratings. The Navy has recognized this and has extensively studied the validity of the Basic Test Battery (BTB), predecessor of the ASVAB, and ASVAB Forms 6-10 since 1962. Numerous studies, such as those described in Chapter II, have been made by the Navy Personnel Research and Development Center (NPRDC), San Diego validating ASVAB scores against performance in over one hundred Navy schools as well as in the actual rating performance.



## B. OBJECTIVES

The purpose of this thesis is to examine the predictive validity of the ASVAB AW subtests and composite scores in relationship to success or failure in the P-3 fleet readiness squadron (FRS) acoustic operator training syllabus as well as to final school grades (FSG) and academic remediation. Additionally, Aviation Antisubmarine Warfare Operator (AW) "A" school final school grades will be correlated to acoustic operator training success or failure, final school grades and academic remediation.

## C. RESEARCH METHODOLOGY

The data base for this thesis consists of sixty-one non-rated AWs who attended the FRS acoustic operator training course during FY 1984 at PATROL SQUADRON (VP) THIRTY-ONE at Moffett Field, California. Their AW "A" school and acoustic operator training scores were obtained from VP 31 training records and their ASVAB scores were obtained from the Enlisted Master Tape Record (EMR) maintained at NPRDC, San Diego.

Bivariate correlations ( $R_s$ ) between the ASVAB AW composite score (the Basic Electricity/Electronics, BE/E predictor  $AR + 2MK + GS$ ) and individual subtests and school performance were developed by using the Pearson product-moment correlation method, corrected for restriction in range.

#### D. ORGANIZATION OF THE STUDY

This research effort is organized into eight chapters. Chapter I is a broad introduction presenting an overview, objectives and the research methodology of the study. Chapter II presents a review of literature dealing with Navy studies of ASVAB predictive validity in relation to technical training. Chapter III provides background information dealing with manpower determinants and Navy manpower issues. Chapter IV presents historical information about the development of the ASVAB and its use in the Navy. It gives a description of the ASVAB subtests, both generally and those used to select AW personnel. It looks at validation of the ASVAB scores in relation to rating success as well. Chapter V explains the AW rating in general with a short discussion of the VS (fixed wing deployable antisubmarine warfare (ASW) community) and the HS (helicopter ASW community) with emphasis on the VP AW community. It will provide an explanation of the AW positions onboard the P-3 aircraft and the related NECs as well as general flight crew duties. Chapter VI provides a discussion of the training an acoustic operator receives, including recruit training, aircrewman school, AW "A" school, acoustic operator training and post FRS training (primarily OJT). Chapter VII presents the data derived from the correlations between the predictor and criterion

variables, briefly explaining the methods used, and details the data analysis. Chapter VIII discusses the results of the study and conclusions made by the author and makes recommendations for future research.

The Appendix provides a glossary of Navy acronyms and terms used throughout this study.

## II. REVIEW OF LITERATURE

### A. INTRODUCTION

The Services have long recognized that enlistment standards and criteria for selection to technical ratings must be periodically evaluated to ensure they are still effective predictors of professional success.

This chapter reviews research conducted as part of a continuing Navy program to evaluate the effectiveness of measures used in the assignment of recruits to Navy schools and to establish standards for school entry. Not meant to be a comprehensive study of all the Services' related validation studies, this review will only highlight Navy research.

### B. VALIDATION OF ASVAB COMPOSITES TO TECHNICAL SCHOOL PERFORMANCE

#### 1. Objectives and Methodology

NPRDC, San Diego has studied BTB and ASVAB composite validity in more than 10 separate research studies involving over 100 Navy technical schools spanning a period of 15 years. In a 1984 study, Booth-Kewley summarized the prime objectives common to all of these studies when she said:

The major objectives of the research were to (1) examine the validity of ASVAB selector composites, including the AFQT, for predicting performance in a wide variety of Navy schools, and (2) identify and evaluate ASVAB



composites that predict performance in specific schools better than do the operational composites. [Ref. 1: p. 2]

The methodology for reaching these objectives was to use the current ASVAB selector composite for a rating as well as the 12 selector composites used by the Navy to determine eligibility for all the rating groups as predictor variables. The primary criterion variable for performance was final school grade (FSG) for the applicable technical school. Other performance criteria such as days to graduation, final status (pass/fail) and times remediated, which were seen as primary performance measures of lesser importance than FSG, were also used. The sample groups were composed of students enrolled in applicable Class "A" Schools who had taken the ASVAB test. [Ref. 2: p. 2] [Ref. 3: pp. 1-2] [Ref. 4: pp. 1-2] [Ref. 5: pp. 1-2]

Pearson product-moment correlations of ASVAB selector composite predictors to the performance criteria were performed. The resulting validity coefficients were corrected for restriction in range. To provide the most accurate correlations possible, multiple correlations between the aggregated ASVAB test scores and each criterion measure were calculated using a stepwise regression procedure to determine the most predictive composites. From these data, expectancy tables were constructed for the operational (current) composite as well as for promising

alternative composites to demonstrate whether the desired result of providing enough students who could successfully complete training would occur at the current cutting score as well as a variety of others. [Ref. 6: pp. 1-4] [Ref. 7: pp. 9-11] [Ref. 8: p. 4] [Ref. 9: p. 3]

## 2. Results, Conclusions and Recommendations

The results in the four most recent validity studies showed that the operational composites were predictive, to varying degrees, of the primary criterion - FSG. In the study of 100 schools, the selector composites predicted performance reasonably well with an overall median corrected validity coefficient of .55. [Ref. 10: p. 21] In the cryptologic technician technical (CTT) study the operational composite was again moderately predictive of FSG with a corrected validity coefficient of .50 [Ref. 11: p. 4], while the cryptologic technician collection (CTR) composite was only a fair predictor at .34. [Ref. 12: p. 5] In the strategic weapons systems electronics (SWSE) study the operational composite was the highest of the predictors with a corrected validity coefficient of .78. [Ref. 13: p. 8] The research showed that no other selection composites for any of the ratings were significantly better predictors of FSG, except in two cases, electrician mate and quartermaster. [Ref. 14: p. 26] In the SWSE study Booth-Kewley recommended keeping the operational composite

but raising the cutting score based on the expectancy table data. [Ref. 15: pp. 12, 14]

All of these studies point to the fact that current selector composites are moderately to fairly predictive of performance and are within accepted Navy requirements. In the CTR study, for example, Booth-Kewley concluded, by examining the expectancy tables for the operational and experimental composites, that changing the CTR selector composite would not reduce academic attrition. She recommended that other possible explanations for the school's high attrition rate be investigated. [Ref. 16: p. 19]

### III. MANPOWER DETERMINANTS

#### A. INTRODUCTION

This chapter will discuss how enlisted manning for each rating is determined and how the ASVAB composite cut-off scores for acceptance into enlisted ratings are decided. The two processes are independent of each other although there are some inter-relationships between them. Policy regarding the management of enlisted personnel assigned to naval activities is contained in OPNAVINST 1000.16E. This instruction addresses the topic of enlisted management in a broad fashion, with other instructions detailing specific areas of management, such as training.

Most information about manning level determinations and cut-off scores for ASVAB composites is general knowledge among those at the policy level who make these decisions. There is very little written historical background on the subjects other than current instructions which give very few details about the history. As a result, most of the information presented in this chapter comes from telephone interviews with manpower experts at the Navy Military Personnel Command (NMPC), specifically NMPC 48, Enlisted Manning and Incentives Division (classification section), NMPC 17, Enlisted Manpower Specialists, and NPRDC



researchers who provide NMPC and the Office of the Chief of Naval Operations (OPNAV) assistants with the behavioral data required to make informed manpower decisions.

#### B. MANNING LEVEL DECISIONS

Squadron Manpower Documents (SQMD) are the basis for determining, at the aviation squadron level, how many billets are required in the different enlisted ratings to perform the required squadron duties.

The SQMD provides a defensible technique for the determination of billet requirements and is published as 5320 series OPNAV instructions. SQMDs are published for identically equipped squadrons as "class" documents. Unique squadrons have individual SQMDs and all aircraft squadrons are included in the SQMD program. The primary factors utilized in the development of the SQMD are the Required Operational Capabilities (ROCs) and the Projected Operational Environment (POE). The ROC provides a definition of the squadron mission, and the POE is a description of the squadrons' wartime environment. Various types of quantitative data are also required to produce an SQMD. Major emphasis is placed on determining the planned and corrective maintenance manhours for the type of squadron. Planned maintenance manhours are extracted from Maintenance Requirements Cards, indirect manhours are extracted from existing standards, and corrective maintenance manhours are computed from historical data. The resulting composite manhours are utilized to forecast the number and type of personnel required to support the scenario specified in the POE, which determines the number and types of billets required. The SQMD thus developed is unconstrained by dollars. [Ref. 17: pp. 13-14]

SQMD manpower requirements are based on work measurements for not only maintenance (the primary criterion), but also requirements for operation, training, support and administrative functions [Ref. 18: p. 1].

The SQMD serves as the basis for the Manpower Authorization (MPA), OPNAV 1000/2. The MPA approximates the SQMD billet requirements, less mobilization billets (which will be filled with Selective Reservists during time of mobilization) [Ref. 19: p. 4]. The SQMD reflects the documented needs of the squadron and doesn't ensure that the number of personnel required to fill those billets will, in fact, be ordered into the command. The OPNAV 1000/2 authorizes the manpower inventory level resulting from constraints in various budgetary and manpower policies and CNO priorities.

In the present economy with restraints on military spending and manpower accessions, many ratings are undermanned so that "fair share" cuts in manning have to be taken by the commands to ensure a fair distribution of the manpower available. In the the case of AWs in fleet VP squadrons, for example, there are usually nine aircraft assigned to the squadron with twelve crews required for efficient manning. That means that 24 acoustic operators (NEC 7821), twelve non-acoustic operators (NEC 7851 or 7861), and one AW shop chief petty officer will be needed to fully man each squadron in the required navy enlisted classification codes (NEC). [Ref. 20] According to NMPC 17, currently only 32 of the 37 billets can be filled due to manning constraints. [Ref. 21] As a result, the Fleet

Commanders-in-Chief (FLT CINCs) and the Enlisted Personnel Management Center (EPMAC) must work together, with assistance from the community, to determine the fair-share manning of these squadrons.

#### C. ASVAB SELECTOR COMPOSITE CUT-OFF SCORES

The determination of the ASVAB composite cut-off score for acceptance into each rating group is determined through behavioral research. As part of the ASVAB studies discussed earlier, NPRDC (for the Navy) investigates the relationship between cut-off scores and attrition from technical schools. Additionally, the NMPC Enlisted Community Manager for the individual rating communities receives listings of school attritions on a regular basis. He looks for trends in ASVAB scores and technical school failures, monitoring these relationships very closely. When he becomes concerned about the failure rate in a particular technical school he will request that NPRDC revalidate the correlation of the ASVAB composite cut-off score to success or failure in the targeted school. The data gathered and the research findings will be used by OPNAV to set the policy as to whether the ASVAB cut-off should be changed or not. NMPC implements the change as required.

This process for determining test cut-off scores was implemented in 1956 when the Secretary of the Navy was given the authority under Public Law to establish new ratings and

to also control entrance into all ratings through test scores [Ref. 22]

#### D. CONCLUSION

This chapter has dealt with two manning matters that are decided separately but have an affect on each other. ASVAB composite cut-off scores are not determined by the number of personnel needed for the rating, but rather through the analysis of an expectancy table which shows what the expected rate of success or failure in the technical school will be based on each cut-off score investigated. This system has been in place for over thirty years and has proven to be relatively successful in predicting success and failure rates based on cut-off scores. As a result, even when new ASVAB test forms are introduced, only very small corrections (usually less than ten points) are made to the cut-off scores [Ref. 23].

Billet requirements and manning levels are determined independently of the number of personnel in the training pipelines for the ratings. Although the two are determined separately, there is a definite relationship between the number of personnel successfully trained for, say, the AW NEC 7821 and the number of billets actually filled with qualified people. As a result, it becomes very important to ensure that every sailor assigned to the lengthy AW acoustic operator training pipeline successfully completes it so that

the number of fleet-available personnel will be as high as possible. Failures at the AW Class "A" level and acoustic operator training phase only exacerbate the manning shortage.



#### IV. ARMED SERVICES VOCATIONAL APTITUDE BATTERY (ASVAB)

##### A. HISTORY

###### 1. Pre-ASVAB Testing

During World War II men weren't accepted for service unless they completed the fourth grade or were able to pass a screening test. Initially the screening was for literacy, but non-language tests were also introduced for service qualification. After service entry, the primary test instruments for assignment purposes were the Army General Classification Tests (AGCT series) which were later supplemented by special tests to measure mechanical, clerical and other aptitude areas. [Ref. 24: p. 1]

Prior to the implementation of the ASVAB in January, 1976 each service had developed and was utilizing its own test battery to determine enlistment and skill eligibility. The Army used the AGCT, the Air Force the Airman Classification Battery (ACB) and the Navy and Marine Corps utilized the Basic Test Battery (BTB). The Armed Forces Qualification Test (AFQT), discussed in a later section, was used as a service-wide screening test to determine trainability for military service. [Ref. 25: p. 1]



## 2. Origin of the ASVAB

On May 1, 1974, the Defense Manpower Policy Council approved the recommendation of Mr W. K. Brehm, Assistant Secretary of Defense (Manpower and Reserve Affairs) (ASD/M&RA), that a single test battery be used by the Services for selecting enlistees and for placing them into the various military occupations [Ref. 26: p. 3].

An ASVAB Steering Committee was established, composed of senior officers and civilians from all the Services, to provide policy recommendations on ASVAB development, implementation and use to the ASD/M&RA. The ASVAB Working Group, composed of Service testing policy staffers and scientists from the Service personnel research laboratories, was established to design the new ASVAB [Ref. 27: p. 4].

The ASVAB was selected because it was already in use by all the Services as the DOD High School Testing Program. The ASVAB was administered at high schools across the country to stimulate enlistments and improve the efficiency of the recruiting program. It provided recruiters with lists of students who were tested, giving their addresses and scores. The information served as a prospect list for recruiters and helped develop and maintain a close and favorable relationship between school administrators and recruiters. [Ref. 28: p. 3] ASVAB forms 5, 6 and 7 replaced

the Service-unique classification batteries in January 1976. Each ASVAB form is a different version of subtest questions which is utilized to try to cut down on cheating by recruiters and prospective enlistees by making it impossible for them to know which test version will be given at the Military Entrance Processing Station (MEPS).

### 3. Implementation of Subsequent ASVAB Forms

The ASVAB test forms are periodically changed to prevent possible test compromise due to long term use and to make modifications to the content determined necessary by factor analysis studies of the tests.

Test Forms 8, 9 and 10 replaced Forms 5, 6 and 7 as military selection and classification measures in October, 1980. They were designed to be more accurate at lower levels of ability than were the predecessor tests. They also provided a broader measure of verbal skill than did the earlier forms. Forms 11, 12 and 13 replaced Forms 8, 9 and 10 in October, 1984. [Ref. 29: p. 4] Forms 8, 9 and 10 scores will be the basis for this study because the sample group was administered these tests.

## B. ASVAB SUBTESTS

### 1. Overview

The ASVAB is a battery of ten subtests (see Table I) administered at the MEPS as part of the screening process for possible military recruits. These subtests are combined

in different composites for use as selection and classification criteria for recruitment and subsequent training.

TABLE I

SUBTEST COMPOSITION OF ASVAB FORMS 8, 9 AND 10

<u>Subtest</u>	<u>AFOT Selector</u>	<u>AW Selector</u>
1. General Science (GS)		X
2. Arithmetic Reasoning (AR)	X	X
3. Word Knowledge (WK)	X	
4. Paragraph Comprehension (PC)	X	
5. Numerical Operation (NO)	X	
6. Coding Speed (CS)		
7. Auto & Shop Info (AS)		
8. Mathematics Knowledge (MK)		X
9. Mechanical Comprehension (MC)		
10. Electronics Information (EI)		
11. Raw score of WK+PC converted to standardized score (VE)		

The Navy utilizes twelve different ASVAB selector composites for different work areas such as clerical, electronics, mechanical, etc. Most of these composites have been evaluated in terms of their ability to predict success in specific technical training courses [Ref. 30: p. 4], as discussed in the review of literature. The Basic Electricity/Electronics (BE/E) composite is the AW training

selector and is a composite of ASVAB subtests AR + 2MK + GS. The cutoff standard score for acceptance into the AW rating at the time of this study was 200 [Ref. 31: p. 2].

Another use of the selector composites is for selection for military service:

One set of four subtests is known as the Armed Forces Qualification Test (AFQT) and is used to screen applicants for eligibility for military service. After meeting the AFQT criteria for selection, a Navy applicant must achieve a passing score in an aptitude area composite for placement into a particular training specialty. [Ref. 32: p. 1]

## 2. ASVAB Calibration and Validation

The ASVAB subtest scores are initially given in raw score form. Raw test scores, however, don't have meaningful units, in part because they vary with the difficulty of the items that make up the test. Test scores are needed that are meaningful even when test difficulty changes. Normalization is used to convert raw scores into percentile scores of a standard reference population. [Ref. 33: p. 1] This allows percentile scores from different tests to have some interpretive meaning. The score scale for Forms 8, 9 and 10 were based on the combined sample of applicants and recruits. The calibration was to express the scores of the calibrated version on the same metric as that used for the 1944 reference population. Such comparability would make possible a comparison of the relative ability of those

tested by Forms 8, 9 and 10, [Ref. 34: p. 8], with the 1944 reference population for entrance and classification purposes. The 1944 reference population was made up of enlisted men and officers that took the AGCT during World War II.

To be meaningful, the ASVAB tests must be constantly studied.

Extensive research and recalibration has been undertaken to insure accurate norming occurs both in the AFQT and ASVAB composite tests of all ASVAB forms. In the case of Forms 8, 9 and 10, for example, their performance was closely monitored and the data collected was used to calibrate and verify the accuracy of the test findings. [Ref. 35: p. 13]

The ASVAB must not only be calibrated for meaningful interpretations but must also be validated against measurable performance criteria to ensure they are validly predicting future performance. The preferred criteria for validation of a selection measure for civilian occupations has always been job performance. Since there aren't any uniform or common measures of military performance, training school performance has become commonly used for validating the selector composites in the military.

The appropriateness of training school scores as a criterion is established by two considerations. First, attrition from training schools represents ineffective manpower utilization. Individuals who aren't trained can't do the job. Prediction of training success is therefore valuable. Second, variables associated with individual assignments introduce extraneous variance into job performance and such extraneous variances don't



correlate with aptitude tests scores and so obscure true validity relationships. [Ref. 36: p. 30]

All Services have performed validation analysis on ASVAB Forms 6 through 10. The Department of Defense ASVAB Test Manual states that in the case of Forms 8, 9 and 10 the validities reported across all job families by all Services are sufficiently strong to provide effective predictors of training success, and thus to reduce training failure rates, decrease training time and promote advantageous employment of enlisted personnel [Ref. 37: p. 54].



## V. A DESCRIPTION OF THE AW RATING

### A. INTRODUCTION

The majority of information discussed in this chapter was gathered from discussions with staff training personnel at PATROL SQUADRON 31 and Fleet Aviation Specialized Operational Training Group Pacific (FASOTRUGRUPAC) at Naval Air Station, Moffett Field, California. These training organizations amplify the general rating knowledge presented in AW "A" School and teach specialized technical courses using the actual equipment found onboard the ASW platforms the students will be operating when they report to the fleet. Most aspects of the AW rating are secret with very few nonclassified documents. Most basic information about the rating isn't available in print, thus requiring interviews with subject matter experts to gain needed information.

What do AWs do in the routine performance of their rating? Speaking in broad terms, they perform general flight crew duties; operate antisubmarine warfare (ASW) sensor systems to extract, analyze and classify data obtained; perform specified preflight, inflight and postflight diagnostic functions using manual techniques, built-in test equipment (BITE), and computer routines to

effect fault isolation and optimize system performance; assist in aircrew briefing and debriefing; provide data base information to the Tactical Commander for use in prescribing mission objectives and tactics. At the E-4 level, they may be required to: obtain and interpret information from airborne bathythermograph recordings; identify sounds produced by surface ships, submarines, evasion devices, marine life and other natural phenomenon; and perform inflight functions checks on airborne acoustic systems.

To be selected for the AW rating, an enlistee must meet a set of requirements that are relatively stringent. These requirements include:

1. ASVAB composite score of:  $2MK + AR + GS = 200$  (cutting score waivers allowed on a case-by-case basis)
2. normal color vision
3. vision correctable to 20/200
4. normal hearing
5. no speech impediment
6. must be a U.S. citizen
7. must be a class III swimmer and must pass class I swimmer while in school
8. rating is closed to women

[Ref. 38: p. 1]

As with many technical Navy ratings, the AW community performs its professional duties of undersea surveillance with more than one type of equipment and on more than one

platform. AW personnel are utilized on three different airborne platforms and employ both acoustic and nonacoustic equipment on the aircraft. The helicopter platform (HSL and HS) is based on Spruance class destroyers and fast frigates, as well as HS aircraft on aircraft carriers, and utilizes one AW who employs dipping sonar (Sound Navigation and Ranging) to detect submarines. Most information gathered by the AW on the HSL aircraft is sent back to the ship for interpretation because computers aren't employed on the helicopter platform. Helicopter ASW is usually utilized close to the aircraft carrier or surface ship. The VS community utilizes carrier based S-3 aircraft which can perform medium range ASW support for the carrier. The S-3 aircraft has two AW positions, one acoustic and one nonacoustic. One position is filled by an AW and the other usually by the co-pilot, NFO or another AW. The aircraft has the computer capability to process the data onboard. The VP squadron utilizes P-3 aircraft which are land-based and are used for long-range support. The aircraft contains two acoustic and one non-acoustic stations.

The research developed in this thesis will deal with the P-3 acoustic operators only. The acoustic operators on the other two platforms perform similar duties in terms of acoustic detection but also perform other duties as described above. The non-acoustic operators deal primarily

with electronic surveillance measures (ESM) which detect radar sources other than their platform's in the area and magnetic anomaly detection (MAD) which looks for disturbances in the Earth's magnetic field, usually from large metal objects such as submarine hulls. They also operate the infrared radar (FLIR) equipment, a TV-like display, used to sight surface objects during darkness.

#### B. ACOUSTIC OPERATOR REQUIREMENTS

The acoustic operators studied in this thesis hold a 7821 NEC which specifies them as P-3 acoustic operators. They are ordered into their operational squadrons based on this NEC which is awarded upon successful completion of the acoustic operator pipeline. The acoustic operators' primary duty onboard the aircraft is to detect, locate and classify a target, using the computer to process the target signal information. They must be able to recognize signatures for a wide variety of submarines as well as surface ships and other contacts appearing on the lofargram (paper display) or acoustic display (CRT system) at their station. The operators must be able to extract the submarine sounds from background noise to assist them with identifying the sound source. The combination of the visual and aural identification and formulation of mathematical relationships of gears is all interconnected in determining the identity of the target. The operator must also be able to determine

the course and speed of the target after localization by interpreting signals transmitted by the sonobuoy. This assists in attack strategy.

In performing his mission, the acoustic operator must listen to passive sonar which uses hydrophones, or underwater microphones, to transmit target and ambient ocean noise. He must also be able to listen to and view on the CRT screen, (found at both the Sensor One and Sensor Two positions on the P-3 illustrated in Figure 5.1) the emissions of the active sonobuoy which acts much like radar, sending out a "ping," or an acoustic wave, that returns after hitting something. Although passive sonar is preferred because it doesn't give off a tell - tale sound to warn the enemy of its presence, both types are widely used, thus acoustic operators are required to be proficient with both. To fully understand what the sonar is telling him, the operator must also have a knowledge of oceanography, the way sound velocity is affected by the temperature, salinity and pressure of the water. He must be able to determine the velocity of the sound and its propagation path by measuring the salinity (which is fairly constant), the pressure (which increases with depth) and most importantly the temperature of the water (the colder the temperature the slower the velocity).



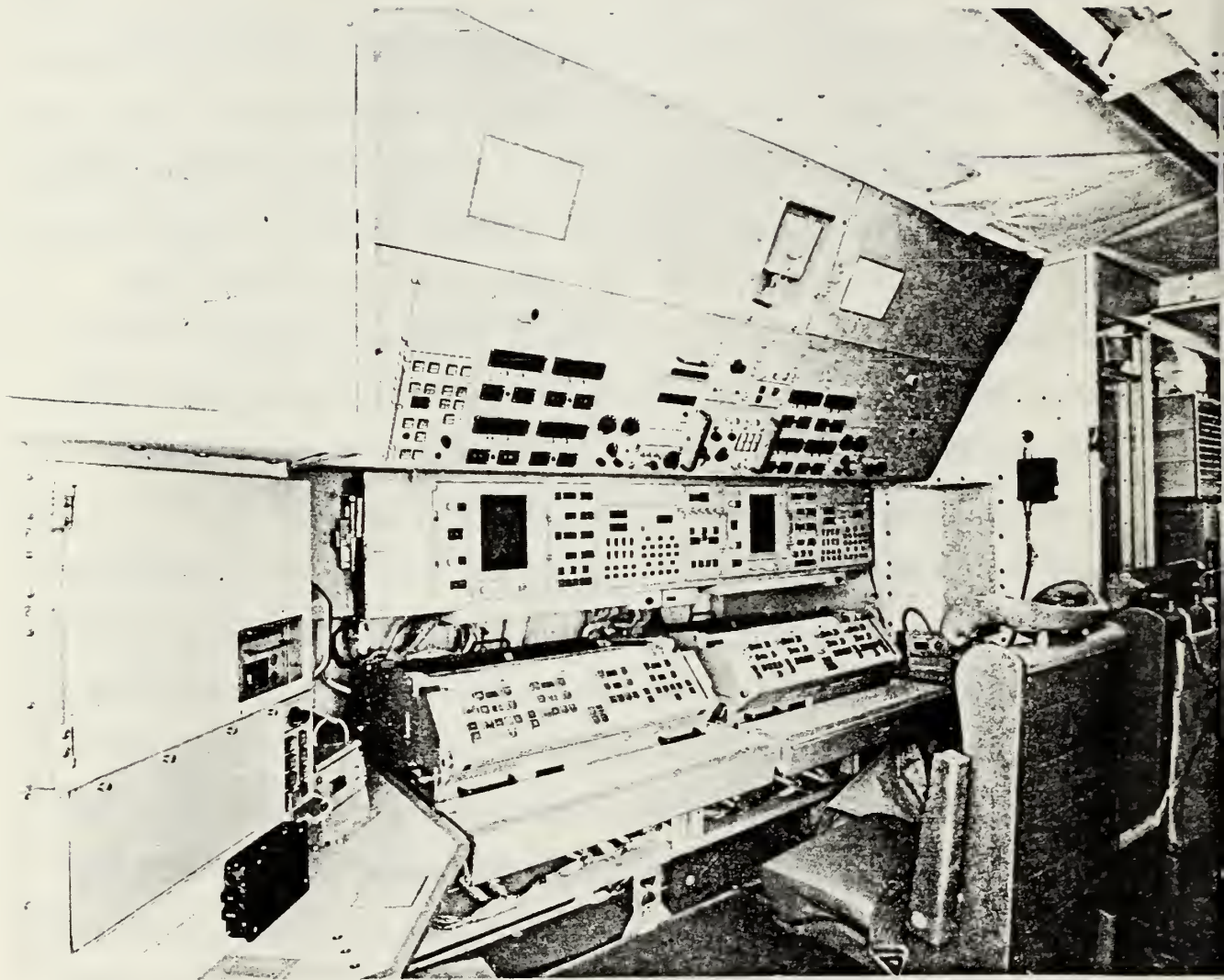


Figure 5.1 P-3 Sensor One and Two Positions



In addition to his professional AW duties, the acoustic operator must also be a qualified aircrewman, able to perform general aircrew duties assigned to all aviation ratings.

#### C. THE PATROL SQUADRON TEAM

The two acoustic operators are members of a twelve man team that works together to search, locate, track and attack enemy targets. All twelve must work together as a cohesive team to ensure a successful mission. The same team works together over a long period of time so that they can develop their ability to work together in a synergistic mode.

The team is made up of the following personnel:

1. Pilot, Co-pilot and Third Pilot - responsible for flying the aircraft and for flight safety.
2. Flight Engineer and Relief Engineer - positioned in the middle cockpit seat, this enlisted member maintains appropriate engine power settings and monitors aircraft flight systems. Works very closely with the pilot and co-pilot, especially to ensure flight safety.
3. Navigator - responsible for communication onboard and for setting the plane's course to the ASW prosecution point.
4. Tactical Coordinator - responsible for positioning the sonobuoys in effective patterns in the water and for receiving information from the acoustic operator about target sightings so that he can locate the position of the target. Coordinates the tactical flight crew in the operational environment
5. Acoustic Operators - as described earlier, these positions provide accurate information about target identification and location.

6. Non-acoustic Operator - provides information about other radar sighting in the area and possible MAD contacts.
7. In-Flight Technician - a technician trained to keep the electronic gear properly performing during the flight
8. Ordnanceman - responsible for loading and dispensing sonobuoys from the aircraft.

The senior, most qualified officer (usually the plane commander (pilot) or the tactical coordinator) is designated the mission commander and is responsible for the overall mission. He gives the command to drop ordnance on the target when required.

Since the crew works so closely together, they are all responsible for safety and for ensuring that the mission (which can last up to twelve hours depending upon the distance to the on-station site) runs smoothly. The mission is a crew evolution, with all members working closely together. Figure 5.2 illustrates the crew stations on a P-3 aircraft.

The acoustic operators are vital members of the team because without them the crew couldn't detect, locate and identify the target upon which their mission rests. Because the acoustic operators' job is so important, they must be qualified to perform their function immediately upon reporting to the team. The Sensor One station is manned by the senior operator with the Sensor Two station held by a more junior person in the field. This allows some

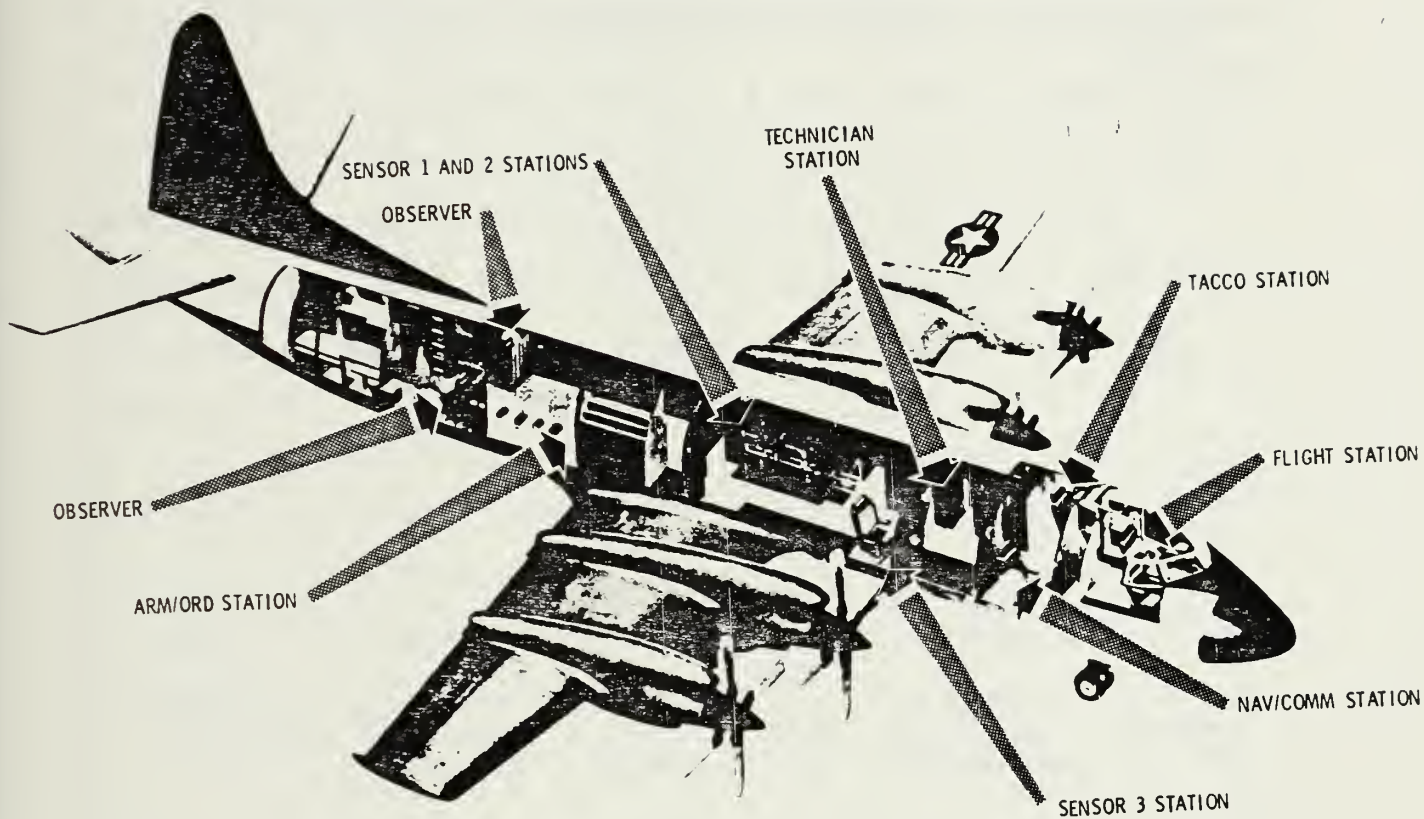


Figure 5.2 P- Crew Members

assistance to be given to the junior operator by the senior, but in most cases the operator is expected to be well enough trained to detect and identify targets without assistance. This is the most important reason why an acoustic operator must be trained well enough in Class "A" School and Acoustic Operator Training to successfully perform his duties from "day one."

## VI. ACOUSTIC OPERATOR TRAINING

### A. INITIAL TRAINING

The training pipeline that all acoustic operators must follow is illustrated in Figure 6.1. The men first attend recruit training command which is a seven week program to provide indoctrination and orientation in basic skills and knowledge for newly enlisted naval personnel which will enable them to make the transition from civilian to the Navy environment and to prepare them for follow-on specialized training.

7 weeks	5 weeks	11 weeks	18 weeks	11 weeks	
Recruit Training	Aircrew Candidate School	AW "A" School	FASO	Fleet Readiness Squadron	Fleet

Figure 6.1 Training Pipeline for the  
AW Acoustic Operator Community.

Following recruit training, all aviation ASW students spend two weeks at the Aircrew Candidate School, Naval Air Station (NAS), Pensacola, Florida gaining the knowledge required of an aircrewman, particularly in regard to flight



operations and safety procedures. This course is taken by all enlisted aviation personnel who will be members of a flight crew regardless of aircraft type or mission. Instruction specific to acoustic analysis is not included.

#### B. AVIATION ANTISUBMARINE WARFARE OPERATOR "A" SCHOOL

After completion of Aircrew Candidate School the students attend AW "A" School in Memphis, Tennessee. This eleven week course provides the student with a basic introduction to sonar principles and physics of sound, as well as acoustic analysis. The three week acoustic analysis portion of the course includes instruction on physics of sound, acoustic intelligence, and sound source identification techniques.

Acoustic analysis instruction at this introductory level is geared toward teaching students how the acoustic data on a lofargram (the visual representation of the sound waves at the Sensor One and Two positions) relates to the sound sources that generate those displays. Students are not taught a specific analysis procedure in "A" School, but are instructed on how to identify various frequency lines being generated by specific sources of sound. Examples of these sources include: the submarine's hull causing turbulence in the water, the bearings and transmission gears in the submarine engine, nuclear submarines' coolant pumps for the nuclear reactor, and propellers agitating the surrounding



water as the submarine moves through the water. Students practice their basic skills and knowledge of acoustic analysis using static linear grams which are reproductions of actual submarine signatures. These grams are generic because the students have not learned specific submarine signatures (characteristics of specific man-made sounds emanating from the submarine).

In addition to acoustic analysis, the students are given general, introductory instruction in math, navigation, oceanography, sonar principles and non-acoustic methods including MAD and ESM (discussed in the previous chapter). These courses are all general in nature, giving the students an introduction to areas they will become more versed in at later stages in their education. A raw score of 65 is required for graduation from the course of study.

#### C. FASO AND FRS ACOUSTIC OPERATOR TRAINING

Upon completion of AW "A" School, personnel that will be ultimately ordered to VP squadrons to fill the acoustic operator sensor positions (NEC 7821) are sent to FASOTRAGRUPAC/LANT (commonly referred to as simply FASO) for an eight week acoustic analysis course. This course reviews acoustic fundamentals taught at AW "A" School. It teaches the students how to obtain information from the gram and, then, to apply specific acoustic intelligence information to identify the target. They are given classroom instruction

on how to identify specific diesel and nuclear submarines from the signatures appearing on the lofargrams as well as signatures of surface ships and natural phenomena which may occur.

The students work with static grams to learn to identify the target. These practical application laboratories give them an opportunity not only to identify the target but to begin to develop skills in tactical applications such as determining the range of the target from the buoy, as well as the depth, speed and course of the target.

Math is emphasized because the operator must be able to mathematically verify his target identification and location as well as justify the frequency analysis he selects. Oceanography is stressed because factors such as water temperature, salinity and pressure all have an affect on sound velocity and must be carefully assessed in making tactical decisions.

Upon successful completion of the FASO training phase the students are assigned to the FRS which is colocated with FASO. The eleven week training course is designed to develop skills on the specific sonar equipment they will use upon assignment to their ultimate duty station and to facilitate learning of the crew-based skills required on the P-3 aircraft.

General aircrew training includes familiarization with the P-3 model the students will be flying in at their operational squadron. They must learn to perform functional systems preflight and postflight duties using the maintenance manuals for their station to determine a complete systems status with a minimum amount of assistance. They must be able to perform safety and survival equipment preflight inspections as well as equipment inflight checks to determine system status. The students must learn aircraft emergency procedures both at their own station and throughout the aircraft if needed, including the use of aircraft emergency equipment. Aircraft safety is highly stressed in the FRS training, including observer duties such as engine start observer and in-flight observer. The students are also taught general knowledge about aircraft systems and circuit breaker locations for safety.

Acoustic operator training in the P-3 sensor one and two stations includes ensuring an in-depth understanding of analysis and classification of targets using specific installed equipment. Additionally, an understanding of basic acoustic tactics, extracting tactical data such as determining the target's closest point of approach (CPA), and calculating target course and speed are perfected through the use of the lofargram analysis techniques. Data annotation requirements for sightings of possible targets

are also presented. This training is a specifically oriented follow-on to the general acoustic training the students have received at "A" School and FASO.

Approximately fifty percent of FRS training is instructor-taught with weekly tests to gauge learning ability with the other half taught through self paced instructional system (IS) workbooks . Students who receive a score of less than 80 on a weekly test must retake that test and can be remediated to a later class if they aren't able to grasp the information being presented. A cumulative score of 80 is required for successful completion of the training, although most students who failed had a score above 80 but had failed two or more weekly tests in a row and usually showed other problems as will be discussed in Chapter VIII.

#### D. POST-FRS TRAINING

Upon completing FRS training the students are transferred to their ultimate operational command. They are expected to be proficient acoustic operators upon reporting to these commands although they are placed in the Sensor Two position beside a more experienced operator. Most operators receive no further formal school training after the FRS. An advanced acoustic operator course for Sensor One operators, that provides in-depth gram analysis, has been recently introduced by FASO. A written entry exam is required to

determine if prospective students have enough prior acoustic knowledge to grasp the higher level of analysis taught in the class. Predeployment training is also provided to familiarize operators with acoustic operations in the area they will be deploying to, but no real additional analysis is taught.

Most acoustic operators must hone their abilities through simulator practice and on training and operational missions. On the average, it takes an AW approximately two years to become a proficient acoustics operator. It usually takes them eighteen months to earn their aircrew wings (qualification) through experience.

The operators are assisted in on-the-job-training (OJT) by the Anti-submarine Warfare Operations Center (ASWOC) which is made up of senior operators who evaluate the audio and paper tapes annotated by the operator during operational and training missions. ASWOC awards grades to the acoustic operators as a result of the mission debriefs and reconstruction. These grades are a part of the crew's On Station Effectiveness grade (OSE) which reflects on squadron readiness.



## VII. DATA PRESENTATION, ANALYSES AND RESULTS

### A. OVERVIEW

The primary goal of this thesis is to investigate the relationship between the AW ASVAB operational (selector) composite and performance in acoustic operator training. A secondary goal is to determine if predictor variables closely tied to the operational composite are predictive of the same training performance. Determining whether they are reliable predictors of training performance will aid AW managers in how to screen AW "A" School graduates for selection for follow-on training.

### B. DATA BASE

As discussed briefly in Chapter I, the data base for this research effort consists of 61 nonrated AWs who attended the FRS portion of the acoustic operator training pipeline during FY 1984. Demographics of the sample group include: ASVAB operational composite score range of 198 to 274; an acoustic operator training score range of 79.2 to 98.2; AW "A" School FSG range of 74.5 to 98.3; 55 successful completions of the acoustic operator training and six failures.



## 1. Predictor Variables

The process of determining the predictor variable for this thesis was based on professional judgement of reliable predictors and was reinforced by choices made in similar studies, as discussed in the review of literature. The primary predictor variable was the BE/E operational composite (AR + 2MK + GS) used for selection to the AW rating. Secondary predictor (selector) variables investigated were: AW "A" School FSG and the individual subtests comprising the operational composite. The other ASVAB subtests and operational composites were also inspected because they were correlated to the criterion variables as a result of the computer programs utilized.

## 2. Criterion Variables

FSG was used as the primary criterion of successful acoustic operator training performance. Additional performance criteria were student pass/fail status and whether the student had been academically remediated. Graduates were assigned a code of "1" and failures a code of "0". The data didn't differentiate between academic and non-academic failures although, as discussed in the following chapter, descriptive information about each failure was gained through interviews with the squadron training coordinator. Personnel academically remediated were assigned a code of "0" while those students who were not academically remediated were assigned a code of "1".

### C. DATA ANALYSES

Pearson product-moment correlations between the predictors and the criteria were computed. The resulting coefficients of correlation appear as single figures that tell to what extent two things are related; to what extent variations in one go with variations in the other [Ref. 39: p. 198]. The validity coefficients were corrected for restriction in range, using the multivariate procedure, to reflect the coefficients that would be obtained from a sample representing the full range of ability of Navy recruits vice the sample of AW "A" School graduates. The population statistics used for the correction were based on a group of 66,459 regular Navy recruits who entered the Navy from July 1981 to May 1982. The Lawley multivariate procedure was utilized because it is the most accurate estimate for population correlations [Ref. 40: p. 16]. Utilized primarily for continuous data, the corrected results of the dichotomous criteria using the Lawley procedure, are somewhat underestimated.

The resulting coefficients can vary from a value of +1.0, which means perfect positive correlation, through zero which means complete independence, or no correlation, to -1.0, which means perfect negative correlation.

The bivariate and multivariate correlation coefficients of the operational ASVAB subtests and composite with

acoustic operator training FSG, pass/fail and academic remediation are presented in Table II and Table III.

TABLE II

UNCORRECTED & CORRECTED VALIDITY COEFFICIENTS OF  
THE OPERATIONAL ASVAB SUBTESTS & COMPOSITE FOR  
PREDICTING FSG

Selector AR + 2MK + GS = 200	N = 61	
Selector Mean 233.56	Criterion Mean	90.70
Selector SD 17.62	Criterion SD	4.32

<u>ASVAB Tests</u>	<u>ru</u>	<u>rc</u>	<u>ru</u> <u>mean</u>	<u>rc</u> <u>SD</u>
GS	.032	.287	58.18	4.51
AR	.442	.490	57.51	6.13
MK	.467	.570	58.93	5.90
BE/E (AR+2MK+GS)	.475	.566		

ru = uncorrected correlation  
rc = corrected correlation

The correlation between AW "A" School FSG and acoustic operator criteria could only be determined for the sample group because theory-based estimates of the entire population could not be derived for the acoustic operator training course. The bivariate correlation of AW "A" School

TABLE III

UNCORRECTED AND CORRECTED COEFFICIENTS OF THE  
OPERATIONAL ASVAB SUBTESTS & COMPOSITE FOR PREDICTING  
PF & REM

<u>ASVAB Tests</u>	<u>P/F</u>		<u>REM</u>	
	<u>ru</u>	<u>rc</u>	<u>ru</u>	<u>rc</u>
GS	-.122	-.141	.079	.194
AR	.236	.117	.118	.190
MK	.175	.111	.232	.333
BE/E Selector	.168	.061	.217	.312

FSG to acoustic operator training FSG was .719, to pass/fail was .348 and to academic remediation was .363. The AW "A" School FSG mean was 86.39 with a standard deviation (SD) of 5.76.

A general rule of thumb regarding the strength of the correlation of linear relationships of data is illustrated in Figure 7.1.

Inspecting the validity correlation coefficients presented in Tables II and III, one discovers that, at best, the predictor variables are only mildly predictive of the criterion variables.

The test for statistical significance was used as a method of verifying the correlational strengths of the two variables. It means that the observed result could not

<u>CORRELATION</u>	<u>STRENGTH LEVEL</u>
.0 - .2	weak
.2 - .8	mild
.8 - 1.0	strong

Figure 7.1 Correlation Strength Levels.

reasonably be attributed to random variation alone.

[Ref. 41: p. 251]. In this study a one-sided p-value was calculated to show statistical significance at the .05 level.

#### D. RESULTS

As shown in Table II, the operational composite is only mildly predictive of the acoustic operator FSG ( $r_u = .475$ ,  $r_c = .566$ ). The GS subtest was a weak predictor of FSG ( $r_u = .032$ ,  $r_c = .287$ ) while the AR and MK subtests were mildly predictive ( $r_u = .442$ ,  $r_c = .490$  and  $r_u = .467$ ,  $r_c = .570$  respectively). All of the coefficients were statistically significant at the .05 level.

All of the subtests and the operational composite were weakly correlated to the pass/fail criterion (see Table III). The GS subtest was negatively correlated ( $r_u = -.122$ ,  $r_c = -.141$ ) and the selector was extremely poor in predictive capability ( $r_u = .168$ ,  $r_c = .061$ ). None of these



correlations were significant at the .05 level which means that these figures could be due to random variation although there is no way to know with certainty.

A further inspection of Table III reveals that the predictor variables for academic remediation are a little more valid than those for pass/fail, but still only mildly predictive. For example, the MK subtest is the best predictor ( $r_u = .232$ ,  $r_c = .333$ ) with the operational composite the next best predictor with rather weak validity coefficients ( $r_u = .217$ ,  $r_c = .312$ ).

In terms of the subtests, the GS test is the poorest predictor in all three cases with the AR test superior in only one case and the MK scores highest in two.

The highest validity coefficient was a .719, very close to being a strong correlation, between AW "A" School FSG and acoustic operator training FSG. The other bivariate coefficients, .348 (pass/fail) and .363 (academic remediation), were weak. All were significant at the .05 level. The reason that there is such a low correlation between AW "A" School FSG and the pass/fail criterion is that although the cut-off score for passing the acoustic operator training is technically 80, five of the six failures had a cumulative FRS score higher than 80. An interview with the VP 31 Training Coordinator revealed that the cumulative scores were misleading because all of these

men had failed at least two acoustic operator training tests with extremely low scores. He indicated that the cumulative score isn't always the squadron's primary criterion for success or failure in the course, as will be discussed later. Additionally, a review of the "A" School training records for those who passed and failed acoustic operator training showed that the men who failed had substantially lower "A" School scores than their peers. For example, one academic drop graduated last in his "A" School class and two were academically remediated in AW "A" School. The records of those men who completed the entire training pipeline did not show the same high proportion of academic problems as those who were academically dropped.

The Lawley correction program produces composite validity coefficients for all the operational Navy composites (twelve of them) and the AFQT with the criterion variables. Although not directly studied in this thesis, it is interesting to note that no other composite is significantly more predictive than the BE/E Composite of acoustic operator training FSG. The only higher correlation is the the General Technical (GT) Composite validity coefficient of .580, only .014 correlation points higher.

## VIII. CONCLUSIONS AND RECOMMENDATIONS

### A. CONCLUSIONS

The primary purpose of this research has been to provide acoustic operator pipeline managers with an insight into the relationship between ASVAB predictor variables and acoustic operator training performance.

The correlational analyses results indicated that, as discussed in the review of literature, the operational selector composite is only a fair predictor of success or failure in the acoustic training course, and as a result the entire training pipeline. The individual subtests do not give any better indication of ability to complete the pipeline successfully. The impact here is immense because if a student fails the acoustic operator training he loses his AW rating, becoming a non-designated striker (AN) who then must be sent to the fleet to learn another rating. This not only means a new start for this young sailor in another rating, but also means that over a year's worth of highly technical, expensive training has been virtually wasted. With the shortage of qualified AWs, both acoustic and non-acoustic operators, this only exacerbates the manning shortages facing the operational squadrons.

The highest correlation coefficients were between AW "A" School and acoustic operator training final school grades. Empirically this would stand to reason since the courses are so closely linked. The problem is that the relationship between AW "A" School scores and success or failure in completing the last leg of the training pipeline is relatively weak. With a failure rate of 10 percent (six out of 61 students), it becomes apparent that successful completion of "A" School doesn't always guarantee remaining in the AW rating.

Discussions with subject matter experts (SME) at VP 31, FASO, and NPRDC reveal that they have developed their own theories about why a man succeeds or fails in acoustic operator training. Reviewing the training schools' academic records (vice the legal or medical records, for instance) has led the author to develop similar hypotheses about intangible factors that are key to training performance. Two different types of problems present themselves. First, the majority of the academic failures appear to be due to a lack of motivation to learn the subject area. There was little attempt made by these men to seek extra assistance when needed, a lack of dedication to night study and minimal effort being displayed to find a solution to their academic problems. They just didn't seem to care. This can be seen in both "A" School and in the FRS training. The second

problem was a desire to succeed but a lack of scholastic ability to grasp the subjects being taught. Comments about poor study habits were found in half of the academic drop files.

Although there is no data to support this conclusion, it appears that intangible behavioral patterns could be a large part of the reason for academic failure. These young men (most are only 19 or 20), with little prior formal training past high school, appear to have a lack of motivation to study in some cases that may be predictable in their previous Navy school scores but apparently not in their ASVAB scores.

#### B. RECOMMENDATIONS

As a result of this study, as well as those conducted by NPRDC for other ratings, the author would recommend retaining the current ASVAB selector composite. Since none of the ASVAB composites appear to be strong predictors of technical school performance, the current composite can be used with the realization that it gives only a fair prediction of success or failure.

A factor that appears to affect FSG which can only be inferred from this study is poor study habits. A method to determine the reason for low performance levels could be developed by educational experts and students with low test scores or other academic problems could be screened to



determine if their problems are, in fact, due to poor study habits. If poor study habits are found to be a problem, a short course to teach good study habits could be implemented either at the "A" School or FRS level to correct these deficiencies. Potential failures who were given this instruction and other study-related guidance could be followed to determine if their performance improved. This could result in what may appear to be failures for other reasons, such as poor attitude or lack of motivation, being properly identified and assistance provided to improve academic performance.

If the ten percent attrition rate is considered too high by the AW pipeline managers, they should re-examine how FRS (acoustic versus non-acoustic) training is assigned. Although personal choice in training is an important psychological factor, the managers may consider assigning "A" School graduates to the different aircraft platforms and AW positions based on their "A" School scores. More study would need to be done here, since this thesis only looked at acoustic operator training and requirements.

Another recommendation that is supported by the data is that AW "A" School graduation criteria may need to be raised. Since most of the failures in the acoustic operator training course had low "A" School scores, raising the cutting score would result in fewer failures in FRS

training. This solution may not result in more acoustic operators, but it would eliminate some of the academically unprepared personnel who do not have the ability to successfully complete training and that take up most of the instructors' and administrators' attention, leaving more time for the successful students.

#### C. RECOMMENDATIONS FOR FUTURE RESEARCH

In his study to determine the relationship between ASVAB standards and actual job performance measures for AWs, Bearden found that the current ASVAB composite results in a success rate of 48 percent for the AW sample [Ref. 42: p. 5]. The author believes that future research should center on the intangible, motivational factors that affect the way we learn, work and interact with other human beings. A study of the attrition rates for all AW training (acoustic and nonacoustic), with an emphasis on whether they are acceptable or too high, and what causes the failures, could be undertaken. Factors other than ASVAB scores, such as educational and ethnic background and demographic characteristics should be investigated for possible predictors. If other predictive factors can be identified as valid, a new pass/fail criteria could be developed utilizing those predictor variables.

A study to determine the reasons for low performance could be undertaken, with the results used as guidelines for

establishing identification criteria and corrective procedures.

## APPENDIX

### GLOSSARY

ACB	Airman Qualification Battery (Air Force)
AFQT	Armed Forces Qualification Test
AGCT	Army General Classification Test
AN	Nonrated airman
AR	Arithmetic reasoning ASVAB subtest
"A" School	The initial technical training school in a Navy rating.
ASD/M&RA	Assistant Secretary of Defense (Manpower and Reserve Affairs)
ASVAB	Armed Services Vocational Aptitude Battery
ASW	Antisubmarine warfare
ASWOC	Antisubmarine warfare operation center
BE/E	Basic Electricity/Electronics
BITE	Built-in test equipment
BTB	Basic Test Battery (Navy)
CPA	Closest point of approach
CRT	Cathod-ray tube
CTR	Cryptologic technical collection
CTT	Cryptologic technician technical
DOD	Department of Defense
EMR	Enlisted master tape record
EPMAC	Enlisted Personnel Management

	Center, New Orleans, Louisiana
ESM	Electronic surveillance measures
FASOTRAGRUPAC/LANT (FASO)	Fleet Aviation Specialized Operational Training Group Pacific/Atlantic
FLT CINCs	Fleet Commanders-in-Chief
FLIR	Flight infrared radar
FRS	Fleet Readiness Squadron
FSG	Final School Grade
GS	General science ASVAB subtest
MAD	Magnetic anomaly detection
MEPS	Military Entrance Processing Station
MK	Mathematics knowledge ASVAB subtest 2 x MK used for AW selector criterion
MPA	Manpower Authorization (OPNAV 1000/2)
NEC	Navy Enlisted Classification
NFO	Naval flight officer
NMPC	Navy Military Personnel Command
NPRDC	Navy Personnel Research and Development Center, San Diego, California
OJT	On-the-job-training
OPNAV	Office of the Chief of Naval Operations
OSE	On-station effectiveness
POE	Projected operational environment
REM	Academic remediation
ROC	Required operational capabilities



SQMD	Squadron Manpower Document determines enlisted organizational manpower requirements
SWSE	Strategic weapons systems electronics
VP	Patrol squadron (PATRON)
VS	Fixed-wing antisubmarine aircraft squadron

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